Quantum physics - course description

General information

Course name	Quantum physics
Course ID	13.2-WF-FizD-QP-S17
Faculty	Faculty of Physics and Astronomy
Field of study	WFiA - oferta ERASMUS
Education profile	-
Level of studies	Erasmus programme
Beginning semester	winter term 2023/2024

Course information

Semester	2
ECTS credits to win	6
Available in specialities	Physics
Course type	obligatory
Teaching language	english
Author of syllabus	• prof. dr Zbigniew Ficek • dr hab. Sylwia Kondej, prof. UZ

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Class	30	2	-	-	Credit with grade
Lecture	30	2	-	-	Exam

Aim of the course

To teach students advanced methods of quantum physics and their applications.

Prerequisites

Knowledge of the basic concepts quantum physics, covered in the undergrad course "Quantum mechanics foundations".

Scope

- Basic concepts of quantum physics. Non-relativistic Schrodinger equation - Revisited.

- Multidimensional potential wells: Quantum wires and quantum dots.

- Density operator and its representations.

- Matrix representations and their applications.

- Electron spin. Pauli matrices and their applications.

- Quantum dynamics and pictures. Unitary transformations.

- Quantum harmonic oscillator. Annihilation and creation operators and their algebra.

- Quantum theory of two particles.

- Interaction of simple quantum systems with external fields. Zeeman and Stark effects. Diagonalization of the interaction Hamiltonian. Dressed states.

- Quantum model of two interacting systems. Entangled states.

- Time independent perturbation theory.

- Time dependent perturbation theory. Fermi golden rule.

- Entropy in quantum physics.

- Relativistic Schrodinger equation: Klein-Gordon equation.

- Dirac equation. Negative energy states. Spinors.

Teaching methods

Two hours per week are scheduled for lectures and two hours for tutorials. Lectures will cover the formal course content. Tutorials, solving problems and exercises on topics related to the lectures.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
Apply the mathematical methods of quantum physics to solve practical problems, and analyse the results.		• a discussion • a test • an exam - oral, descriptive, test and other	• Lecture • Class
Demonstrate the ability to apply several approximate methods.		• a discussion • a test • an exam - oral, descriptive, test and other	• Lecture • Class
Is familiar with matrix representation of operators and wave function.		• a discussion • a test • an exam - oral, descriptive, test and other	• Lecture • Class
Demonstrate the ability to extend the non-relativistic to relativistic approach to quantum physics problems.		• a discussion • a test • an exam - oral, descriptive, test and other	• Lecture • Class

Assignment conditions

Lectures: Final written exam. To obtain a passing grade student should provide correct answer to at least 2/3 of questions.

Tutorial: Activity during the tutorial hours demonstrating the ability of solving tutorial problems and a positive grade of the final test. Before taking the final lecture examination the student needs to obtain passing grade of the tutorials.

The final grade: the arithmetic average of the tutorial and lecture examination grades.

Recommended reading

1. E. Merzbacher, Quantum Mechanics, (Wiley, New York, 1998).

2. R. Eisberg and R. Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, (Wiley, New York, 1985).

3. D. J. Griffiths and D. F. Schroeter, Introduction to Quantum Mechanics (Cambridge University Press, 2021).

4. C. Cohen-Tannoudji, B. Diu, F. Laloe, Quantum Mechanics: Volume I: Basic Concepts, Tools, and Applications, Volume II: Angular Momentum, Spin, and Approximation Methods, (Wiley-VCH, 2019).

Further reading

1. A. S. Davydov, Quantum Mechanics, (Pergamon, Oxford, 2013).

2. L. I. Schiff, Quantum mechanics, (McGraw-Hill, New York, 2010).

3. N. Zettili, Quantum Mechanics - Concepts and Applications (Wiley, 2022).

Notes

Modified by dr hab. Maria Przybylska, prof. UZ (last modification: 30-04-2023 17:20)

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